Name:_____

NASA/Tropical Rainfall Measuring Mission (TRMM)

Topic #2:Hurricanes as Heat Engines

Activity #2:Satellite Images of Hurricane Rainfall Data.

National Science Content Standards A,B,D,E,F & G

OBJECTIVE: To interpret satellite images of hurricane rainfall data.

BACKGROUND: Hurricanes draw their power from humid air over warm oceans. The ocean's heat is absorbed by water as it evaporates. As the warm humid air rises, it cools and condenses into cloud droplets or rain. This process of condensation releases **latent heat** into the surrounding air. As upper levels of air absorb the released latent heat, it is likely to rise, cool and condense to form increasing clouds and rain. To replace the rising air currents powerful winds **converge** the storm. The constant inward flow of humid air supplies the storm with the water vapor that condenses into heavy rain. This repeating process which releases heat has caused hurricanes to be compared to engines. The hurricane heat engine uses latent heat as fuel which is **convert**ed to wind and rain.

Presently scientists are using satellite instruments to measure rainfall and the latent heat that is released during the formation of clouds and rain in the tropical regions of Earth. The instruments use radar and microwave sensors to collect data as the satellite passes 215 miles above the Earth's surface. Making 90 minute orbits, the satellite makes two passes over each area daily. The region of the Earth from which data will be collected lies between 35 N latitude and 35 S latitude. With increased data from this Tropical Rainfall Measuring Mission (TRMM), scientists will be able to create more accurate computer models for the study of global climates and hurricanes. As concern mounts over the possibility of **global warming** and severe hurricanes due to warmer ocean temperatures, there is a growing need for information. With more data scientists may be able to predict the intensity of hurricanes and improve computer models that predict climate change

The Tropical Rainfall Measuring Mission satellite collects data which is assembled with the use of a computer to create an image on a map. Varying amounts of rainfall are assigned colors. The greatest intensity of rain has been assigned the color red with decreasing amounts as follows: yellow, green, and blue.

VOCABULARY:

Converge – to come together
Convert – to change
Global Warming- the gradual warming of Earth's average air temperature
Latent heat – heat "stored" in and released from water as it changes phase

MATERIALS:

Computer with Internet access to web site < http://trmm.gsfc.nasa.gov>
Internet Activity Sheet " Hurricanes as Heat Engines"

NAME:_____

INTERNET ACTIVITY SHEET "Hurricanes as Heat Engines"

PROCEDURE:

1. Using an Internet Service enter the address < http://trmm.gsfc.nasa.gov>
2. Select "Image/Movie Archive" from the menu at the top
3. Select " Image Library"
4. Select "Hurricanes"
5. Select "Mitch" and select the bottom image "Medium [126K]"
   (file name: http://trmm.gsfc.nasa.gov/data/HurrMitch981027.1.MD.JPEG)
   A. If Mitch is moving from east to west (right to left), will this storm make its next landfall in Florida which is located in the upper right of the image? _____
   B. Will this pass of the satellite collect information about rainfall in Florida? _____
   C. The eye of a storm has less rain because air is warming as it sinks. Assuming that rain intensities range from red (highest) to dark blue (lowest), how can you use rainfall amounts to help you locate the eye (center of the storm)?

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6. Go back to "Hurricanes" menu. Select "Susan". Select top image "Large [181k]"
   (file name: http://trmm.gsfc.nasa.gov/data/trmm3dcyclonesusan_md_new.html)
   This storm is called a cyclone because it is located in the region of the Pacific Ocean near northeastern Australia.
   D. The eye of the storm shows a marked drop in rainfall. List the colors from the center of the eye to light blue.
      _____
   E. What is the approximate position of the dark blue of the eye?

      Latitude _____S Longitude _____E

   F. What is the date of this image? _____ This storm is located in the southern hemisphere which has seasons opposite to the USA. During what season did this cyclone occur? _____
7. Go back to "Hurricanes" menu. Select "Bonnie". Select top image "Medium [95k]"
   (file name:http://trmm.gsfc.nasa.gov/data/big_bonnie1.md.jpg)
   These towering clouds reach 59,000 feet into the sky from the eye wall. By comparison, the world's tallest mountain, Mt. Everest, is 29,000 feet tall and commercial jets fly at about 25,000 feet. These clouds formed just before the air pressure dropped from 977 millibars to 957 millibars over 24 hours. A lower air pressure results in higher winds as the storm strengthens.
   G. From these observations, what can you hypothesize (guess) about the development of tall clouds and the intensity of the storm?

H. Red indicates areas of heavy rain. Compare the amount of rainfall in the tallest cloud with rainfall amounts in the surrounding tall clouds. _____

I. As warm air rises, it cools and condenses to form clouds. This process releases latent heat which warms the surrounding air which then rises to condense into clouds. Based on this information, what is your conclusion about the amount of latent heat being released in these clouds as compared to the rest of the storm?
_____

In the margin to the right, sketch an
Illustration of the tall clouds in Hurricane Bonnie --------→

8. Go back to the "Hurricane" menu. Select "Hurricane Slice".
Select "Large [75k]"
(file name: http://trmm.gsfc.nasa.gov/data/9711hurrslicethrubg.html)
This image shows a slice or cross-section of a hurricane.
   J. Describe the gray tops of the storm to the right:
   _____

   K. Looking at the cross-section, what is the predominant (mostly seen) color? _____

   L. Are the red areas of heavy rain, near the top or bottom of the storm? _____

9. Go back to the "Hurricane" menu. Select "Cyclone Pam". Select "Large [165k]"
(file name: http://trmm.gsfc.nasa.gov/data/pam_closeup_md.html)
These images show rainfall distribution for two horizontal cross-sections of Cyclone Pam. Cross-section A –B is shown at the bottom and cross-section C-D is shown to the right.

   M. Describe the general shapes formed by the yellow and red rainfall data in cross-section A-B._____

   N. Using cross-section A-B, what is the approximate height of the tallest readings of blue rainfall data? _____

   O. What is the width of cross-section C-D? _____

   P. What is the Latitude_____ S and the Longitude_____W of Cyclone Susan?